

FABRICATION AND CHARECTERISATION OF ALUMINUM-GRAPHITE COMPOSITE MATERIAL

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ABSTRACT

Matel matix composites have better properties and performance, compared to the pure metals that justifies their added cost. The present work includes fabrication of metal matrix composite having Aluminium as a base metal and Graphite as the reinforcement. The mechanical testing of the fabricated composite is performed and the mechanical properties are compared with the properties of pure Aluminum. Structural material characterization of the fabricated composite was also performed by X-ray diffraction. Mechanical properties of the fabricated composite were fornd superior to the pure metal.

KEYWORDS: Composite Material, Aluminium, XRD & Matel Matrix Composite

Received: Jun 01, 2017; Accepted: Jun 14, 2017; Published: Aug 01, 2017; Paper Id: IJMPERDAUG201731

INTRODUCTION

Composite materials have light weight and superior properties, when compared to the pure metal [1]. The use of Aluminium composite is quite common in structural applications, transportation and power sector. The modern technology requires materials with lighter weight, higher strength and supirior mechanical properties. Aluminum metal matrix based composite material comprises high tensile strength, high melting temperature, light weight and good wear resistance [2].

In the present work, the Aluminium composite was prepared by the casting. Different compositions of the graphite were selected with the Aluminium. Mechanical testing of the prepared sample was performed and a comparision of the result is also presented. XRD was also performed foe structural cherecterisation of the prepared powdered sample.

FABRICATION OF ALUMINIUM –GRAPHITE COMPOSITE MATERIAL

The simplest and most commercially used technique is the casting method. Casting is usually liquid reinforcement contact, which can cause considerable interface reaction. One of the major difficulties is the cost of production in the fabrication of particulate metal matrix composites. Casting is to be considered as one of the cheapest technology available for the fabrication of such composites. In 1968, S Ray introduced casting of metal matrix composites, by introducing alumina particles into Aluminum melt by stirring molten Aluminum alloys containing ceramic powders. In casting, mechanical stirring in the furnace is regarded to be the key element. Despite of the technical challages like achieving uniform dispersion of reinforcement within the matrix, casting is effective way of fabricating such composites. However, improper distribution may affects directly on the properties of the composite material. In the present research, Aluminium matrix alloy with Silicon Carbide and

Graphite reinforcements was fabricated using casting much low cost fabrication will enable Aluminium matrix composite to move forward aerospace and defense applications to, AMCs higher volume applications. The Table 1 refelects the compositions of the samples prepared in the present work. The process of casting, operating parameters and processing and preparation of AMC material using Al 6061 as matrix alloy and reinforcement Graphite have been fabricated by varying weight fractions. Among all well-established metal matrix composite fabrication methods, casting is most economical. Casting is currently the most celebrated commercial method of producing aluminum based composites. The major advantages are simplicity, litheness and applicability to large quantity production. It is also striking because, in the principle of operation, it allows a conventional metal processing route to be used, and hence minimizes the final cost of the product.

Table 1: Sample Composition

COMPOSITE MATERIAL	PERSENTAGE	AMOUNT
Aluminium + Graphite	97%+3%=100%	350gm+20gm=370gm
Aluminium+ Graphite	95%+5%=100%	335gm+35gm=370gm
Aluminium+Graphite	91%+9%=100%	310gm+60gm=370gm

In the present study, the effect of Graphite on cast Aluminum Metal Matrix Composites has been discussed. 3 kg of Al 6061 alloy pieces in the furnace is heated and allow the same to melt at the 1000⁰ C and care has been taken to achieve complete melting. The alloy pieces are kept in the crucible and preheat the mould at the required temperature 1000⁰C. Preheat the reinforcement's graphite at the same temperature range. Slag has been removed using scum power to avoid poor quality casting and maintained at the same temperature for about 20 minutes to remove the moisture casting. Approximately 5% weight of solid dry hexachord-ethane tablets or degassing tablets has been used to degas the molten metal at temperature 1000⁰C. Process of the molten metal to create vortex by means of casting process and the temperature of molten metal has been maintained around 1000⁰C. Further casting of the mixture is performed for achieving the uniform distribution. The mould was also pre-heated to avoid shrinkage.



Figure 1: Furnace

Figure 1 show the Furness utilized in the process. Casting is appropriate for manufacturing composites with up to 30% volume fractions of the reinforcements. The prominent concern associated with the casting process is the segregation

of reinforcing particles which is caused by the surfacing or settling of the reinforcement particles during the melting and casting processes.

RESULT AND DISCUSSIONS

Tensile Testing

When we make the composite material by adding reinforcement then in the phase of reinforcement adding tensile strength of the material is increased with the increase of volume fraction of the composite reinforcement. Comparing mechanical properties alloys contains less Percentage of " Al_2O_3 " as compared with alloy which contain the higher percentage " Al_2O_3 " which shows some higher strength and ductility in metal is founded when we change the %age to up and down. The similar effect of the processing parameters and causes of porosity in cast & heat treated sample of aluminum composites were found by number of other investigators on side ring the experimental results of alloy 3 which show highest tensile strength 260 MPa, 245MPa, 230MPa was due to proper wetting and uniform distribution of ceramics particles in aluminum matrix composite. Similar effect of distribution of material reinforced with " Al_2O_3 " particles. The casting aluminum composite material usually contained porosity and the degree of porosity depend on the processing parameters such as pouring temperature ,types of matrix and volume fraction of reinforcements and the size of particles of reinforcement in the process to complete the reinforcing. After getting these data readings it is observed from the experimental work that Mg content up to 3.9% increases the wetting ability of the ceramics particles as compared to alloys which contains less amount of Graphite it compare to this or no graphite.

Table 2: Tensile Strength of the Fabricated Composite

S No.	Composite	Tensile strength
1-	Aluminium + Graphite (97%+3%) = 100%	230 Mpa
2-	Aluminium + Graphite (95%+5%) = 100%	245 Mpa
3-	Aluminium + Graphite (91%+9%) = 100%	260 Mpa

Table 2 refelects the effect of adding graphite in aluminium on tensile strength he similar effect of graphite in this alloy has been found by other investigators [3-22]. It is also given that the tensile strength of the composite material is increases as the percentage of " Al_2O_3 " particle increase in as cast aluminum alloys up to 3.9% " Al_2O_3 " particles in as the cast conditions. This increase is due to the presence of " Al_2O_3 " and silicon metal Particles which act to refine the grain size of aluminum casting composites by nucleating fine grains size during the solidification process after the heat treatment in as cast conditions. The decrease in tensile strength and ductility with increase the volume fraction of " Al_2O_3 " particles up to 15% in as cast condition have been observed in aluminum alloy metal matrix.

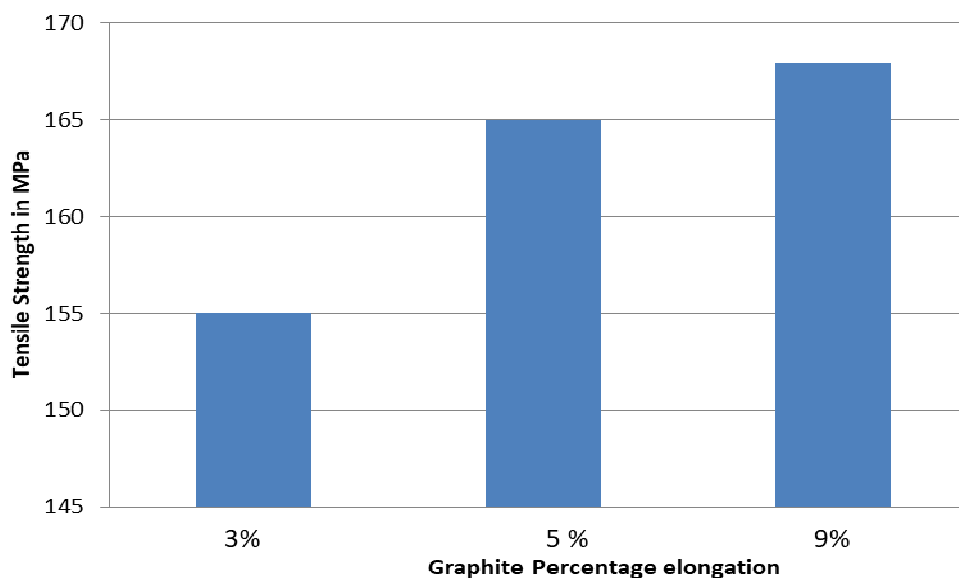


Figure 2: Tensile Test Results

The experimental results of this project especially in alloy 1, 2 and 3 showing good aging response on mechanical properties of aluminum alloy matrix cast composite. The effects of Cu-Zn-graphite metals that are present in aluminum matrix using SiCp were investigated by number of investigators [10-11, 15, 21-22]. In this work when we compare mechanical properties of present work with the previous work conducted by other researchers using casting method, giving superior responses to strength increases up to 260MPa and ductility upto17% with addition of 10% "Al₂O₃" particles the Reinforced in aluminum matrix and when we added some amount of Graphite.

The figure 2 reflects that, if the quantity of Aluminium is 97% and graphite is 3% taken, the tensile strength becomes 230 Mpa. If graphite (5%) is taken, the tensile strength becomes 245Mpa and further increament in the graphite percent to 9 % the tensile strength increases upto 260Mpa. It can be clearly noticed that on increasing the composition of constituents of fabricate composite material the tensile strength of the material increases. The results showed that addition of graphite has increased the tensile strength. It was difficult to have the uniform distribution of the graphite above 9 %.

Impact Test

Izod test was conducted on the specimens of fabricated composites. The table 3 and clearly reflects that the graphite addition positively influenced the impact strength of the composite. Figure 3 also shows that on increasing the composition of constituents of fabricate composite material the impact strength of the material increases. If the quantity of Aluminium (97%) and graphite (3%) is taken, the Impact strength becomes 155 Joule of tensile strength. If graphite (5%) is taken, the Impact strength becomes 165 Joules and further increament in the graphite percent to 9 % the tensile strength increases up to 168 Joules.

Table 3: Impact Strength of the Composite

S. No	Composition	Energy Absorbed
1-	Aluminium-Graphite (97%+3%)=100%	155 joule
2-	Aluminium-Graphite (95%+5%)=100%	165joule
3-	Aluminium-Graphite (91%+9%)=100%	168 joule

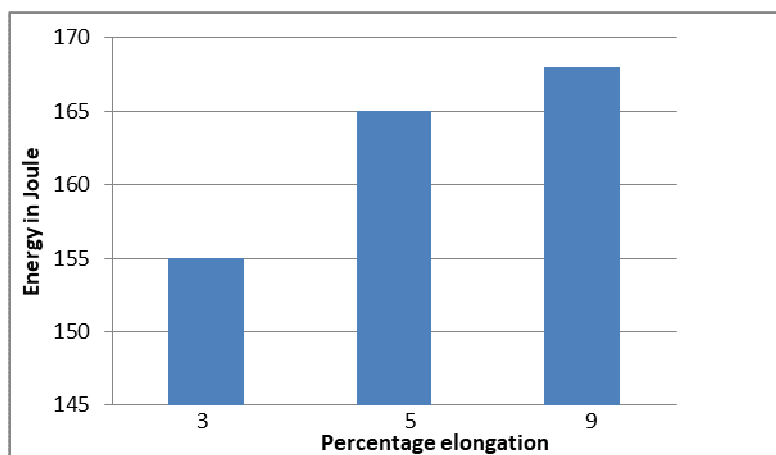


Figure 3: Impact Test Results

X-Ray Diffraction (XRD)

X-ray diffraction (XRD) was also performed on the powdered material the results of same is presented in the figure 4. Peaks of aluminium-graphite and magnesium can be observed from the results. There is some unmathed peak representing the presence of moisture in the powdered sample.

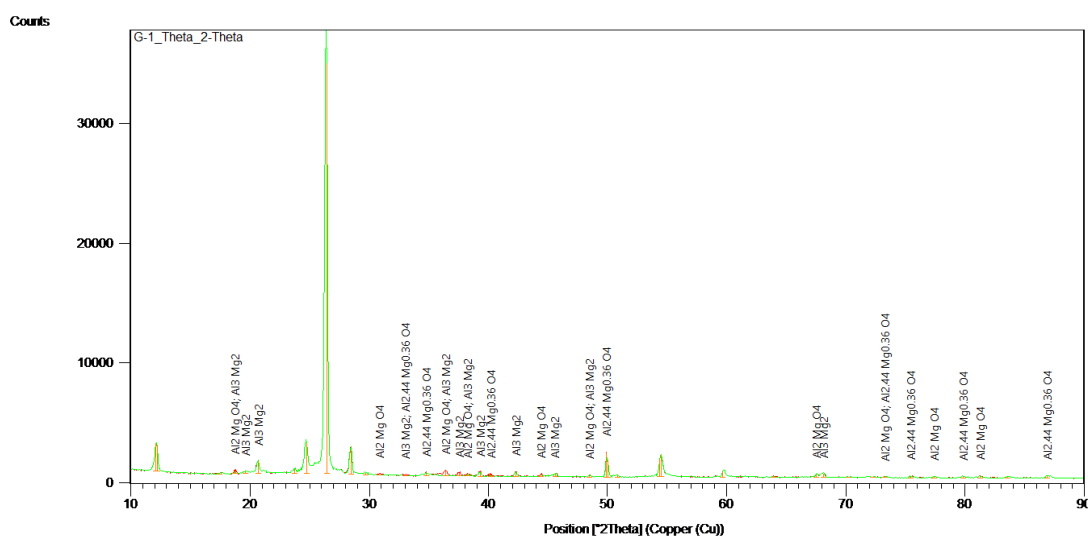


Figure 4: XRD Results

CONCLUSIONS

The Particles Reinforced Aluminium Matrix Composites (PRAMC) have recognized supreme recognition in electronic packaging and thermal management such as power module base plates, printed wiring board cores, microprocessor lids or electric enclosures, for their flexible fabrication techniques, adaptable thermo - physical properties and reliable specific mechanical properties. Generally, the hybrid metal matrix composites have higher thermal conductivity and low thermal expansion coefficient, The hybrid composites not only have the desirable low CTEs , but also have relative low content of Silicon Carbide reinforcement compared to Al-SiC_p composites. PRAMC have an edge over fiber reinforced composites as they are cheaper, have isotropic properties and have the potentiality to be processed using the technology similar to that used for monolithic materials. Al/SiC/Graphite hybrid metal matrix composites exhibits better and favorable thermal properties and are extensively used for aerospace application. In future, the composite

materials will produce significant changes both in aircraft manufacture and industries. They provide structural efficiency at lower weights than equivalent metallic structures. Advanced composites are rapidly emerging a primary material for the use in next - generation aircraft structures. The technology of advanced composites has already well advanced, where all newly emerging military aircraft systems have a number of composite components in production. For next-generation aircraft system, high volume production should make use of composites that are highly competitive with metals. Thus, to expand the existing production base and prepare for the projected high - volume, cost competitive production, airframe the manufacturers must re - evaluate and upgrade their requirements, facilities and technology significantly.

The Conclusions Drawn from the Present Investigation are as follows

- Graphite aluminium, the waste generated from alumina plant can be successfully used as a reinforcing material to produce Metal-Matrix Composite (MMC) component in the aluminium matrix to be used in wear environment. It can be successfully used in place of conventional aluminium intensive material, there by a saving of about 15 percent matrix material could be achieved.
- There is good dispensability of graphite aluminium particles in the aluminium matrix which improves the hardness of the matrix material and also the wear behavior of the composite. The effect is increase in interfacial area between the matrix material and the graphite aluminium particles leading to increase in strength appreciably.
- The specific wear rate of the composite decreases with addition of the filler volume fraction, and after attaining a minimum value (15-20%) it again increases. Thus there exists an optimum filler volume fraction which gives maximum wear resistance to the composite.
- Many parameters e.i., sliding velocity, sliding distance and load are responsible for wear. However, It is more appropriate to express the sliding wear results in terms of wear co-efficient (K), extracted from Archard's law. The Wear Co-efficient (K) is a Correlations factor between several variables of the sliding wear experimental results. For the present case it is found that wear co-efficient tends to decrease with increasing particles volume contact (15-20%), which confirms that graphite aluminium addition is beneficial in reducing the wear of aluminium graphite aluminium composite.
- The results indicate that quenching of heat treated samples in water gives better wear resistance than that achieved by air cooling. This is due to higher cooling rates attained in water quenching which induces more strain in the samples when compared to those induced by the air cooling.

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